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STATISTICAL ASSOCIATION.

I. WHAT IS THE CENTER OF AN AREA, OR THE CENTER OF A POPULATION? By John F. Hayford.

II. ELEMENT OF LABOR IN RAILWAY EXPENDITURE. By Andrew L. Horst.

III. REVIEWS AND MISCELLANY: Notes on Vital Statistics, *C.-E. A. Winslow*; Statistics of Diseases, *C.-E. A. Winslow*; Recent Sanitary Reports, *C.-E. A. Winslow*; Mortality Statistics of Italy, *S. W. A.*

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AMERICAN

STATISTICAL ASSOCIATION.

NEW SERIES, No. 58. JUNE, 1902.

WHAT IS THE CENTER OF AN AREA, OR THE CENTER OF A POPULATION?

By John F. Hayford.

There are many curious misconceptions and absurdities in common circulation in regard to the meaning of the expressions "center of area" and "center of population." The educated, as well as the relatively ignorant, man seems to be puzzled in regard to these terms. No accurate definitions of them exist in current usage, nor can satisfactorily accurate definitions be found in the dictionaries. This paper is an attempt to help in the bringing about of a clear conception of these terms and to remove some of the real and apparent absurdities which arise when they are used.

The center of an area is a point such that if a perpendicular be dropped from each point to *any* one line drawn through said center the sum of the perpendiculars lying on one side of the line will be equal to the sum of the perpendiculars on the other side. The point fixed upon by this definition is the same that would be obtained by representing the area by a thin plate of metal of uniform thickness and density and taking the center of gravity, or point about which the plate will balance, to represent the center of area.

The mathematical process of locating a center of area is not difficult. A line is first drawn across the area in any

assumed direction. For convenience it is well to draw this line in such a position that it will pass as nearly through the center as that point can be located by mere inspection. The area is then divided up into small areas each of which lies completely on one side or the other of the selected line. The sum of the products is then taken separately for each side of the line, of each area into distance of the center from the line. The difference of these two sums of products divided by the total area is then the distance which the selected line must be shifted sidewise to make it pass through the center required, and the direction of the shift must be toward the side on which the sum of the products was the greater. In the new position of the line the sums of the products will be the same on the two sides of the line. A second trial line is now drawn in some other direction than the first, and preferably at right angles to it, and the whole process repeated. Two lines will thus have been obtained each of which pass through the required center which therefore must be at their intersection.

It may be noted by the careful reader that in the above process it is assumed that the center of each of the small component areas into which the total area is divided may be determined. If the component areas are regular figures, such as squares or rectangles, there is no difficulty in locating the center of area of each. If they are not regular figures the position of the center of each may be estimated by eye and the accuracy of the final result tested by some indirect process, or these centers may each be located by a separate process similar to that which is used for the whole area. Obviously the smaller each component area is the more accurately can its center be located by eye, and the less is the effect upon the final result of a given error in the location of each such secondary center. Hence any desired degree of accuracy may be obtained by sufficiently minute subdivision.

There are four properties or characteristics of the center of area defined and located, as indicated above, which are important and interesting.

First, as already stated, it corresponds to the center of gravity if the area be considered to be represented by a thin plate of uniform thickness and density.

Second, The point as thus defined is always unique, that is, there is but one center under the definition for each area. After the center has been located by finding two lines each fulfilling the condition that the sum of the perpendiculars on the two sides shall be the same, it will be found that for any other line through this center the condition is also fulfilled. Or, conversely, the center obtained for any given area is absolutely independent of the directions of the two lines used to fix the center. To illustrate, if in a given county there is a man upon the center of each square mile of area and no other population, and if every man travels to the center of area of the county by first going directly east or west to the meridian passing through the center and then following the meridian to the center, the total distance traveled to the westward will be equal to the total eastward travel, and the total distance traveled to the northward will be equal to the total to the southward. The totals will also be equal in pairs if the traveling be done parallel to any other pair of rectangular axes, let us say, northwest and southeast and northeast and southwest.

Third, The sum of the squares of the perpendiculars dropped from each point of the area to a line passing through the center is smaller than for any other line parallel to it.

Fourth, The sum of the squares of the lines drawn from each point of the area to the center is smaller than the sum of the squares of such lines drawn to any other point. Or, in other words, if it be assumed as before that there is a man on the center of each square mile of a county and each man goes to the center over a straight course the sum

of the squares of the distances traveled will be less than if they so traveled to any other point than the center.

The third and fourth properties of the center are chiefly interesting from a mathematical point of view because they indicate a close analogy between the center so defined and the mean of number of quantities.

Aside from the definition of center given above the most common definition set forth is what may be called the median or bisector definition. The center is defined as being the point at which two lines which bisect the area intersect. According to this definition exactly one half of a county lies on each side of a meridian drawn through its center and exactly one half on each side of an east and west line drawn through its center.

Many people believe the center as thus defined to be the same as that given by the definition advocated in this paper and which for convenience we will call the gravity definition as contrasted with the bisector definition. The two definitions do not, however, give the same point except in a few cases. In some cases the two points are far apart.

The bisector definition is often put forward by people who know that it gives a point different from the gravity definition, and who put forward the contention that the gravity definition is absurd. They say, and it is true, that under the gravity definition the addition or subtraction of a given area far from the center moves the center much more than if such area were added or subtracted near the center. They say it is absurd that distant areas should have so much more effect upon the location of the center than near areas. This is not really an absurdity. The quickest way, however, of convincing a man who advocates the bisector definition because of this alleged absurdity in the gravity definition is not by attempting to show him that the alleged absurdity he has pointed out is merely apparent and not real, but by showing him the real absurdities in the bisector definition.

The absurdities of the bisector definition may quickly be brought out by such a diagram as Figure 1.

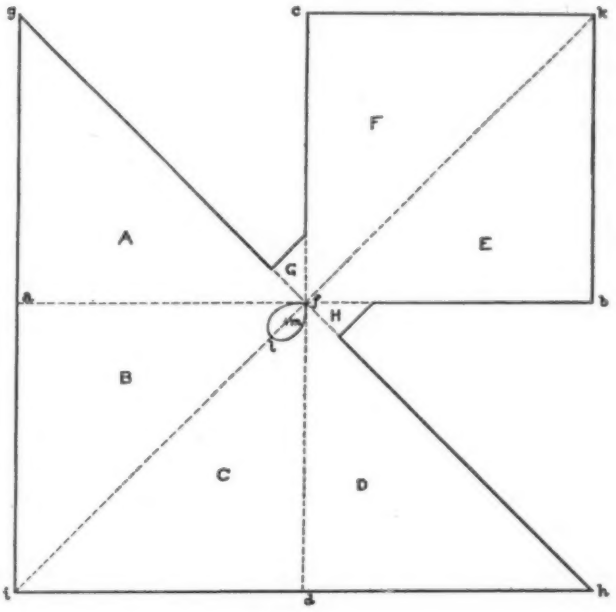

FIG. 1.

The area shown is a square with two portions cut away. Of the triangles into which the area is divided by dotted lines the large triangles *A*, *B*, *C*, *D*, *E* and *F* are all equal and the small triangles *G* and *H* are also equal. The lines *ab* and *cd* each bisect the area and, therefore, by the bisector definition the point *f* is the center. Look now at the line *gh*, which passes through the alleged center *f*. *Four* large triangles, *A*, *B*, *C*, and *D*, lie on one side of *gh* while on the other side there are only *two* large triangles, *E* and *F*, and the two small triangles, *G* and *H*. This line *gh*, which passes through the alleged center under the bisector definition, has nearly two-thirds of the whole area on one side of it. Obviously there is an absurdity here.

If the line *gh* be moved parallel to itself until it does bisect the area it will be found to pass through the point *l*. The line *ik* bisects the area. Hence under the bisector definition *l* is the center of area as well as *f*. In other words, this one area according to the bisector definition has two centers, which is an obvious absurdity.

These two centers under the bisector definition have been obtained by using two pairs of rectangular bisectors of which the second pair are at an angle of forty-five degrees with the first pair. It can be shown that for this area a different center will be obtained for each pair of bisectors used. If only bisectors which are at right angles are used it will be found that this area has under the bisector definition an infinite number of centers all lying in the periphery of an oval having its extreme points at *f* and *l*.

If the advocate of the bisector definition is not sufficiently convinced of its absurdity by the fact that it gives each irregular area an infinite number of centers instead of one he may be invited to consider the matter from another point of view.

It is axiomatic that if any portion of an area be moved the center should also move provided the movement of one portion of the area was not accompanied by a simultaneous, symetrical movement of a similar portion of the area.

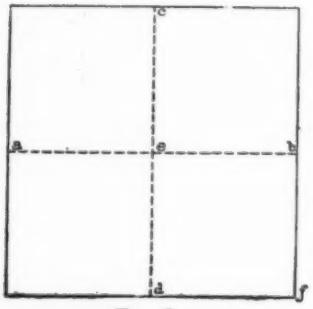

FIG. 2.

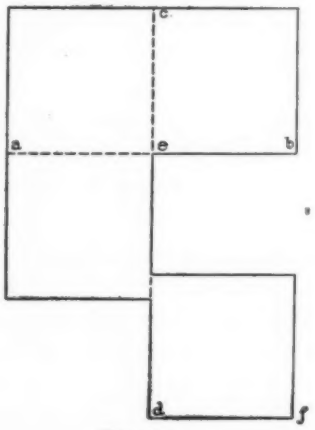

FIG. 3.

Figure 2 represents a square of which the center under the bisector definition is located at *e*, the intersection of the bisectors *ab* and *cd*. Figure 3 represents the same area after the portion *debf* has been moved a considerable distance. The lines *ab* and *cd* are, however, still bisectors and under the bisector definition the center is still at the point *e*. In fact the portion *debf* might have been moved about and distorted to any extent whatever provided no portion of it were carried across either bisector, *cd* or *ab*, without moving the center according to the bisector definition.

Both the absurdities pointed out in connection with the bisector definition are real and are so contradictory to the most elementary and fundamental conceptions of the word center that further comment is unnecessary, except perhaps to call attention by way of contrast to the fact that under the gravity definition each area has but one center, and any movement of any portion of the area will move the center unless it is accompanied by some symetrical movement of another portion of the area.

In Figure 1 the center according to the gravity definition lies within the oval at the point marked *m*.

What is the center of population of the United States? It is defined correctly as follows in Bulletin No. 62 of the Twelfth Census: "The center of population is the center of gravity of the population of the country, each individual being assumed to have the same weight." This corresponds exactly to the gravity definition of a center of area.

The process of locating the center of population as outlined in this bulletin also corresponds exactly to the process of locating the center of area given in the first part of this paper.

Various objectors say that this definition of the center of population is absurd. The greatest apparent absurdity urged in objection is that a man at a distance from the center has much more influence upon the center than a man near at hand. The death of a man in San Francisco moves the

center of population more than the death of a hundred men in Indiana living within ten miles of the center. These objectors advocate the use of the bisector definition for determining the center of population.

In Bulletin No. 62 a concession to these objectors has been made and a "median point" of the population has been located. The "median point" is defined as "the point of intersection of the line dividing the population equally north and south with the line dividing it equally east and west" This corresponds exactly to the bisector definition of the center of an area with the exception that this defintion has carefully been narrowed by limiting the direction of the bisectors to north and south and east and west so that it will give but one median point. If this restriction be removed so that the two bisectors may be taken in any direction it will be found that the population of the United States has an infinite number of "median points" just as the area in Figure 1 has an infinite number of centers according to the bisector definition.

It may be urged that the center of population according to the gravity definition and all the possible median points are all confined to so small an area that it is immaterial which is taken as the center. This proposition will not stand examination.

The median point for 1900 as defined in Bulletin No. 62 is eighty miles to north-eastward of the center according to the gravity definition. This distance is greater than the total movement of the latter point in the last two decades. This distance between the center and the median point of a population depends, firstly, upon the shape of the area over which the population is distributed; secondly, upon the distribution of the density of population over this area; and thirdly, upon the assumed direction of the two bisectors used to locate the median point. The first two of these controlling factors are inherent in the facts but the third depends upon a purely arbitrary decision as to the directions

of the bisectors. Just as the center of area under the bisector definition may be made to travel as indicated in Figure 1 by changing the direction of the bisectors, so the median point of population may be moved by a similar arbitrary decision. After studying carefully a model plate of the form indicated in Figure 1, the writer concluded that an approximate estimate could be made of the direction of a line bisecting the population of the United States which would be at the maximum distance from the median point as located in Bulletin No. 62. The direction was estimated and the position of the corresponding bisector located. This bisector just touches the north-eastern corner of Massachusetts and passes twenty five miles south of Cincinnati. The median point as located in Bulletin No. 62 is seventy miles northward and a little to the westward of Cincinnati. No point of this oblique bisector is within eighty miles of the median point as given in Bulletin No. 62. Another bisector intersecting this one would locate a median point, and it is evident that such a point must be more than eighty miles from the published median point. By arbitrarily changing the direction of the bisectors used to fix it the median point for 1900 can be made therefore to travel about over distances as great as the movement of the properly defined center of population in the last twenty or thirty years.

It may be argued that a knowledge of the exact location of the center of population is of little value, that its location has no appreciable relation of much statistical value to any of the important facts in regard to population. Is this true? In so far as the writer is aware the most important property of the center of population is that its movement from decade to decade indicates the general movement of the population. This is the only important use to which the knowledge of the center has been put in the past, and is absolutely the only use of it made in Bulletin No. 62. Let the relative merits for this purpose of the median point as defined in Bulletin No. 62 and of the center be considered.

As stated in Bulletin No. 62 the movements of the median point "from census to census bear no relation to the movements of the population, since only movements by which bodies of population are transferred across its parallel or its meridian have any influence upon its position." If the whole population of Chicago were suddenly to move to Seattle the median point would remain absolutely stationary. On the other hand, the removal of a hundred men from a certain township in Indiana to the adjoining township on the other side of the median point would move it appreciably. Hence the median point gives no information as to the general movement of the population.

The center of population as fixed by the gravity definition responds to every movement of every individual. It may be shown mathematically, either in the abstract form or from an analysis of the process by which the center is located, that it responds exactly to each movement of every individual by moving in a direction parallel to the movement of the individual, and by an amount exactly proportional to his movement but on a reduced scale fixed by the ratio which this individual bears to the whole population. Thus, if the total population is 75,000,000 and every one stands still except one man the center of population will always move when this one man moves, in a path exactly parallel and similar in every respect to his motion but on the reduced scale of $\frac{1}{75000000}$. If the man moves 1200 miles the center will move about one inch. It is worth while to note in passing that the effect of a given motion on the part of one man upon the position of the center is absolutely independent of the distance of this man from the center. If more than one man moves the movements of the center will be the combined movement due to the different men just as if the movements took place successively instead of simultaneously. Thus if a train moving at thirty miles an hour carries two hundred people the center will respond, provided no other persons move, by moving about five inches each

hour on a path similar in every respect to that followed by the train. If, however, another train were moving at the same time in the reverse direction the movement of the center of population due to this train would partially or wholly neutralize that due to the first train. For, any hour the movement of the center of population is due to the movements of millions of indiviuals, and is the same as if the separate movements of indiviuals had taken place successively and the center had responded on a reduced scale of $\frac{1}{75000000}$ to each in turn. In short the movement of the center of population is an accurate indication on a small scale of the general movement of population.

Or, looking at it from another point of view, the movement of the center of population is an accurate representation of the *average movement of the population.* A movement of a single individual a certain distance is obviously equivalent to a corresponding movement of 75,000,000 people through $\frac{1}{75000000}$ that distance, or the latter motion on the part of the center is the average motion of the whole population.

The movement of the population during a decade is made up not only of the movements of individuals but also of eliminations by death and emigration, and additions by birth and immigration. The effect of the death or emigration of an individual on the position of the center of population defined and computed as indicated in the foregoing is the same as if said individual were first to travel to the center of population and then disappear. Similarly, the effect of a birth or the immigration of an individual is the same as if said individual came into existence at the center of population and then moved to his actual location in the country. This effect of the individuals who appear or disappear from the total population upon the computed position of the center is not so irrational as might seem at first sight. The combined effect of a death in Boston and a birth in San Francisco upon the position of the center should obviously be the

same as if one individual moved from Boston to San Francisco, and this is in turn equivalent to one person going from Boston to the center and disappearing while the other appears at the center and goes to San Francisco. Similarly the combined effect of the landing of an immigrant at New York and the departure of an emigrant from Seattle upon the center of population is and should be the same as if a man moved from Seattle to New York.

VII
VI
X
VIII
IX
NEVADA
COLORADO
ARIZONA
NEW MEXICO

III
IV
V
NORTH
SOUTH
CAROLINA
GEORGIA

ELEMENT OF LABOR IN RAILWAY EXPENDITURES.

By Andrew L. Horst.

For the successful operation of an industrial enterprise provision must be made for depreciation before any earnings can be set aside for the payment of interest or dividends. Any other course consistently followed would soon leave the stock and bond holders only a worthless property. In a factory depreciation is usually provided for by setting aside yearly a certain sum of money from the gross earnings, but the practice of railways differs from this. Roadbed, track and equipment are renewed as fast as they deteriorate, and the cost is charged to operating expenses. In this way the plant is kept up to its standard at the expense of the net earnings, but the effect is the same as if a specific sum had been set aside from the income. This practice of the railways allows them to vary the amount of replacement from year to year according to business conditions. During prosperous years maintenance items may be very heavy, and in times of depression much less of this work may be done because payments to bond and stockholders at such times form a larger proportion of the gross income. The first resort when pressed for money to pay bond interest and to keep up dividends is to cut down operating expenses by stopping repairs and renewals.

The necessity for the reduction of expense is thus brought especially to the attention of railway men in the time of depression. The importance, however, of a systematic reduction in operating expenses, in order to handle traffic economically, is always present. Thus it has been said, "retrenchment is of two kinds, that which is real and that which borrows from the future."[1]

In a time of great necessity much retrenchment is wholly without method, though for a short time great reductions

[1] J. S. Eaton, *Railway Operations*, p. 45.

can be made. Thus it has been pointed out[1] that from maintenance of way and structures 15 or 20 per cent of the entire expenses may be borrowed for six months, from 5 to 8 per cent from maintenance of equipment, and one per cent by a reduction of the labor left in the maintenance departments. During the years immediately following 1893 the saving in cost of operation was largely a borrowing from the capital invested in the property, so that much of the increased expenditures of the last few years has been a repayment at a high rate of discount for these loans.

Real retrenchment, on the other hand, is a systematic reduction and "does not begin at any particular time nor at any particular point, but should be going on all the time and everywhere." This consists of the substitution of new methods and new tools wherever they will produce economy. The complex parts may be so rearranged as to lead to an economy in the operation of the whole system.

The statistics of railway operations in the United States from 1892 to 1900 afford an excellent opportunity to study the results of depression and the consequences of prosperity upon railway operations.[2]

In 1894 the movement of freight traffic was 13,253,007,131 ton-miles, or 14.16 per cent less than during 1893. From 1890 to 1893 the traffic density showed an average annual increase of 25,791 tons carried one mile per mile of line, but in 1894 the decrease was 93,980. Freight train mileage decreased by 61,912,283, while the average annual increase from 1890 to 1893 had been 31,379,733. It followed then that for 1894 every income item showed a decrease. Gross earnings were $147,390,077, or 12 per cent less in 1894 than

[1] J. S. Eaton, *Railway Operations*, p. 47.

[2] This paper is based upon information found in the Annual Reports on the Statistics of Railways in the United States, prepared by the Statistician to the Interstate Commerce Commission, Washington, D. C., 1889–1901.

A suggestive article by H. T. Newcomb, "Some of the Consequences of Railway Prosperity," appeared in *Gunton's Magazine*, December, 1900, in which the effects of prosperity on railway expenditure were shown by comparing the years 1895 and 1899. This paper consequently approaches in some parts the plan there followed.

in 1893, and net earnings $50,883,100 less. The year closed with a deficit of $45,851,294, though operating expenses were decreased $96,506,977, or 11.66 per cent.

To meet this deficit and to make payment of the usual dividends it was necessary to reduce the corporate investment in stock and bonds by $7,094,413, to reduce the cash and current assets by $44,402,673, and to draw upon the fund of materials and supplies to such an extent that the stock on hand was worth $13,988,383 less at the close than at the beginning of the year.

The chief resource in meeting the decline in revenue was to reduce the cost of operation, since fixed charges must be paid and dividends yield only slowly to a decline in income. This reduction in operating expenses amounted to $96,506,977, or 11.66 per cent for 1894. Of this amount $25,588,990, or 26.5 per cent, was taken from the maintenance of way, reduced 15.12 per cent; $23,981,383, or 24.85 per cent from maintenance of equipment, reduced 17.52 per cent; $40,952,540, or 42.43 per cent from conducting transportation, reduced 9.40 per cent; and $5,777,340, or 6 per cent, from general expenses, reduced 6.76 per cent. Or combining maintenance of way and structures and maintenance of equipment, $49,570,373, or 51.36 per cent of the retrenchment was accomplished by reducing expenditures in these departments 16.19 per cent.

Geographically there was a wide variation in the extent of these reductions. Thus the largest total of 17.4 per cent was in the Northwestern States (Group VII), and 13.9 per cent in the Central West (VIII). In contrast to this were Texas and the South Atlantic States (IX and IV). This reduction was accomplished in different items in the several territorial groups. In New England (I) equipment furnished the principal reduction, maintenance of way and of equipment in the Middle States (II), while in the Middle West (III) maintenance of way was most largely reduced. The chief resort in the South Atlantic States (IV), in the Central Northwest (VI), in the Central West (VIII) and

in the Pacific States (X) was the item of equipment. Maintenance of way, on the other hand, supplied the reduction in the Southern Mississippi States (V), the Northwestern (VII) and contributed largely in the Pacific States (X). In contrast to this, general expenses increased in Texas (IX) and the South Atlantic States (IV).

DECREASE OF OPERATING EXPENSES, PER CENT DECREASE 1894 UNDER 1893, AND PROPORTION OF OPERATING EXPENSES 1893, 1894.

Source of Expenditure.	Decrease.		Proportion of Decrease.	Proportion of Total Operating Expenses.	
	Amount.	Per cent.		1893.	1894.
Maintenance of way, etc. .	$25,588,990	15.12	26.51	20.45	19.64
Maintenance of equipment	23,981,383	17.52	24.85	16.53	15.43
Conducting transportation	40,952,540	9.40	42.43	52.60	53.94
General expenses	5,777,340	6.76	6.00	10.33	10.91
Unclassified	206,724	26.76	.21	.09	.08
Total	$96,506,977	11.66	100.00	100.00	100.00
Maintenance: way, structures, and equipment . .	49,570,373	16.19	51.36	36.98	35.07

DECREASE IN OPERATING EXPENSES 1894 UNDER 1893, BY GROUPS AND SOURCES OF EXPENDITURE.

Group.	Total Amount.	Total Per cent.	Maintenance of		Conducting Transportation. Per cent.	General Expenses. Per cent.
			Way. Per cent.	Equipment. Per cent.		
I	$6,538,595	10.75	13.68	26.30	5.04	14.66
II . . .	25,028,656	12.14	17.53	17.79	9.19	8.33
III . . .	16,212,619	12.04	21.95	11.23	10.69	.41
IV . . .	1,390,067	4.56	3.19	15.56	2.37	2.59[1]
V . . .	6,430,385	11.02	15.21	11.87	10.82	3.56
VI . . .	21,408,222	13.45	14.80	22.15	11.47	8.11
VII . . .	5,321,847	17.38	17.15	18.44	16.49	20.22
VIII . .	10,238,600	13.95	11.36	24.09	12.18	12.63
IX . . .	32,434	.10	5.21	2.92	1.85[1]	5.38[1]
X	3,905,552	9.14	10.83	14.12	7.22	5.45
Total . .	$96,506,977	11.66	15.12	17.52	9.40	6.76

[1] Increase.

A comparison of the railways in the Mississippi Valley can be made with those in the Atlantic and Pacific States, and in Texas, from which it is seen that operating expenses in the Mississippi Valley were reduced more than in the rest of the country.

DECREASE IN OPERATING EXPENSES, 1894 UNDER 1893.

Mississippi Valley.			Atlantic, Pacific States and Texas.		
Groups.	Decrease.	Per cent.	Groups.	Decrease.	Per cent.
III . . .	$16,212,619	12.04	I	$ 6,538,595	10.75
V	6,430,385	11.02	II . . .	25,028,656	12.14
VI . . .	21,408,222	13.45	IV . . .	1,390,067	4.56
VII . . .	5,321,847	17.38	IX . . .	32,434	.10
VIII . . .	10,238,600	13.95	X . . .	3,905,552	9.14
Total . . .	$59,611,673	13.08	Total . .	$36,895,304	9.92

A large part of this reduction in expenditure was secured by reducing the number of employees 93,994 or 10.76 per cent. Though this reduction affected all classes, it was greatest among those engaged in maintaining the character of roadway, structures, and equipment. Thus in maintenance of way, where 27 to 29 per cent of the employees are found, the number was reduced about 16 per cent, making up 44 per cent of the total decrease; 25 per cent of the reduction was made by cutting down maintenance of equipment 13 per cent; and 34 per cent by reducing conducting transportation only 8 per cent. If the decrease in the number of employees per 100 miles of line is taken the reduction in the maintenance departments is further shown.

DECREASE IN NUMBER OF EMPLOYEES PER 100 MILES.

Class of Work.	1893.	1894.	Per cent Decrease.
Maintenance of way	151	123	18.54
Maintenance of equipment	103	86	16.50
Conducting transportation	234	208	11.11
General expenses	21	18	14.29
Unclassified	5	8	60.00 [1]
Total	515	444	13.78

[1] Increase.

Interest attaches to the geographical distribution of this reduction. Thus in the whole country the only increase in the number of employees took place in the Pacific States (X), and the greatest decrease in the Middle West (III) and in the Central Northwest. But in these instances exceptional conditions contributed to the result. In the first case 300 miles, not included in the report of 1893, of the Great Northern Railway were put into operation, and the traffic of the latter groups had been especially stimulated by the Columbian Exposition. The largest curtailment of expenditure had been in the Northwest (VII), and here, also, the largest reduction in maintenance and in movement seems to have taken place.

An analysis, according to the classes of employees, shows that the principal reduction was made among trackmen, reduced 16 per cent or 31 per cent of the total, and among laborers. In conducting transportation other trainmen and firemen were the classes to be cut down; and in maintenance of equipment, carpenters and other shopmen. It may then be said that, as between the skilled and the unskilled classes, the chief reduction was made in the classes of comparatively unskilled labor.

DECREASE IN NUMBER OF EMPLOYEES, 1894 UNDER 1893.

Class of Work.	Decrease.		Proportion of Decrease.	Proportion of Total Number.	
	Number.	Per cent.		1893.	1894.
Maintenance of way, etc. .	40,841	15.95	43.45	29.33	27.63
Maintenance of equipment	23,490	13.39	24.99	20.08	19.49
Conducting transportation	32,023	8.05	34.06	45.55	46.94
General administration .	3,635	10.27	3.86	4.05	4.07
Unclassified	5,995[1]	69.54[1]	6.36[1]	.99	1.87
Total	93,994	10.76	100.00	100.00	100.00
Maintenance : way, structures, and equipment . .	64,331	14.90	68.44	49.41	47.12

[1] Increase.

DECREASE IN NUMBER OF EMPLOYEES BY GROUPS AND BY CLASS OF WORK, 1894 UNDER 1893.

Group.	Total Number.	Total Per cent.	Maintenance of		Conducting Transportation. Per cent.	General Administration. Per cent.
			Way. Per cent.	Equipment. Per cent.		
I . . .	7,249	11.06	18.98	7.79	7.99	11.91
II . . .	15,450	6.89	8.69	6.37	6.56	1.29
III . . .	20,680	14.99	27.30	15.72	8.97	10.18
IV . . .	3,698	8.64	17.13	1.46[1]	5.05	1.25[1]
V . . .	8,237	12.40	14.40	18.91	7.25	4.60
VI . . .	26,168	15.36	18.00	12.61	9.68	12.86
VII . .	2,689	10.12	29.34	60.49	38.34	52.91
VIII . .	7,762	10.89	13.84	23.02	9.93	16.37
IX . . .	4,469	12.51	23.47	16.02	8.17	6.29[1]
X . . .	2,408[1]	7.37	14.38	5.42	13.37[1]	25.95
Total . .	93,994	10.76	15.95	13.39	8.05	10.27

[1] Increase.

CLASSIFICATION OF EMPLOYEES, DECREASE AND PROPORTIONATE DECREASE 1894 UNDER 1893.

Class.	Decrease.		Per cent of Total Decrease.
	Number.	Per cent.	
General officers . . . Other officers	425[1]	6.43[1]	.45[1]
General office clerks . .	2,805	10.20	2.98
Station agents	180[1]	.64[1]	.19[1]
Other station men . . .	4,031	5.36	4.29
Enginemen	3,315	8.55	3.53
Firemen	4,032	9.99	4.29
Conductors	2,714	9.86	2.89
Other trainmen	9,542	13.08	10.15
Machinists	1,624	5.26	1.73
Carpenters	5,550	13.25	5.90
Other shopmen	9,350	9.98	9.95
Section foremen	39	.13	.04
Other trackmen	29,443	16.34	31.32
Switchmen, flagmen . .	2,829	6.15	3.01
Telegraph operators . .	474	2.09	.51
All other employees . . .	18,851	16.89	20.05
Total.	93,994	10.76	100.00

[1] Increase.

In contrast to this depression and heroic retrenchment, interest attaches to the revival of industry and the character of the expenditure consequent to this increased commercial activity. For the three years, 1894, 1895, and 1897 the railways of the United States showed deficits; for the year 1893 the surplus was $8,116,745; and for 1896, only $1,534,169. The renewed prosperity of the last few years is shown by comparing the gross earnings per mile of line operated, from which it is seen that gross earnings reached those of 1893 only in 1900; and compared with 1894 showed an increase of 26 per cent.

GROSS EARNINGS FROM OPERATION, YEARS ENDING JUNE 30.

Year.	Per Mile of Line.	Year.	Per Mile of Line.
1890	$6,725	1896	$6,320
1891	6,800	1897	6,122
1892	7,213	1898	6,755
1893	7,190	1899	7,005
1894	6,109	1900	7,722
1895	6,050		

This improvement in revenue represented an absolute improvement, and did not mean, as in the case of an industrial enterprise, exceptional profits made by reason of a rise in the market value of the product, since the revenue per ton-mile increased over 1899 only seven-tenths of one per cent and decreased, under 1893, 17 per cent.[1] There was also no stock of goods on hand, the book value of which could be marked up. The increased revenue was due thus almost solely to an enlargement of the volume of traffic.

This increase in the volume of business involved an addition to the expenses; the number of men was increased, and the outlays for material and supplies were also enlarged. In this way the bulk of the earnings was used up, so that a comparatively small part went to bond and stockholders. Thus, in 1894, though there was a deficit of $45,851,294

[1] The average revenue per ton of freight per mile in 1893 was .878 cents; in 1899 it was .724 cents; and in 1900, .729 cents.

from operation, $95,515,226 was paid in dividends; in 1895, $85,287,543 was paid as dividends, though the deficit from operation was $29,845,241. But, in 1900, $139,597,972 went as dividends, and of this amount $118,624,409 was paid to individuals and corporations other than railways. There remained "available for adjustments and improvements"

INCREASE OF OPERATING EXPENSES, PER CENT INCREASE 1900 OVER 1895, AND PROPORTION OF OPERATING EXPENSES 1895, 1900.

Source of Expenditure.	Increase.		Proportion of Increase.	Proportion of Total Operating Expenses.	
	Amount.	Per cent.		1895.	1900.
Maintenance of way, etc. .	$67,244,177	46.70	28.53	19.84	21.97
Maintenance of equipment	67,385,171	59.22	28.59	15.68	18.84
Conducting transportation	97,967,363	22.72	41.56	59.41	55.04
General expenses	3,421,748	9.53	1.45	4.95	4.09
Unclassified	310,363[1]	34.48[1]	.13[1]	.12	.06
Total.	$235,708,096	32.48	100.00	100.00	100.00
Maintenance : way, structures and equipment . .	134,629,348	52.23	57.12	35.52	40.81

[1] Decrease.

$142,754,358 in 1900, and of this $25,500,035 went into permanent improvements, besides the amounts on account of operation expenses, and $87,657,933 remained as a surplus.

The movement of railway expenditures as a result of these prosperous conditions can be shown by a comparison of the operating expenses for the years 1900 and 1895.[1] Thus the increase of 1900 over 1895 was 32.48 per cent, of which 28.5 per cent came from increasing maintenance of way 46.7 per cent; 28.6 per cent from maintenance of equipment increased 59 per cent. Or, taking these two items together, 57 per cent of the increase was caused by increasing these maintenance items 52 per cent. The effect of this is shown by the proportion of these items in the total operating expenses between the two years.

[1] In 1895 the "Revised Classification of Operating Expenses" was first used, so that the classification used in 1895 and since then differs somewhat from that used in 1894. To make a comparison with 1900 the year 1895 should be used.

This increase in operating expenses should be compared with the reduction made in 1894. Thus maintenance of the property in 1894 was reduced $49,570,373, or 16 per cent, while the total decrease was 11.6 per cent. In 1900 the expenditures for maintenance of the property exceeded those of 1895 by 52 per cent, while the total increase was 32.5 per cent. Thus the increase in 1900 over 1895 of the expenditures for these maintenance items was equal to a return of more than two and one-half times the decrease in 1894. If the comparison is made with 1893, it is found that for maintenance alone $86,260,116 or 28 per cent more was expended in 1900 than in 1893. This was equivalent to the return of the principal borrowed from the property in 1894 and 74 per cent interest.

The effect of this increased expenditure upon business must have been very important. The demands of the railways are diversified and affect many industries. The modification of these demands, due to periods of depression and prosperity, are an important determinant of the activity or stagnation of these important industries. The table on page 69 presents an analysis of the increase in certain classes of operating expenses for the years 1895 and 1900.

These classified expenditures included both direct payments to employees in making the different kinds of repairs and renewals as well as payments to outside firms and individuals for materials that were used in repairs and renewals. The comparison should be made between the increase in items of renewals and repairs and the items of conducting transportation, from which it is found that the increase for engine and roundhouse men was 30 per cent, switchmen 29 per cent, and superintendence 45 per cent. On the other hand, expenditures for buildings and fixtures increased 104 per cent, docks and wharves 79 per cent, freight cars 75 per cent, and locomotives 62 per cent.

INCREASE OF CLASSIFIED OPERATING EXPENSES 1900 OVER 1895.

	Increase.	
	Amount.	Per cent.
Repairs and renewals : —		
Roadway	$32,434,118	46.94
Rails	392,677	3.87
Ties	8,085,028	40.63
Bridges and culverts	9,650,787	63.02
Fences, etc.	2,188,605	62.38
Buildings and fixtures	11,643,452	104.63
Docks and wharves	1,255,226	78.93
Telegraph	509,048	56.18
Locomotives	23,938,112	62.62
Passenger cars	5,944,799	39.82
Freight cars	30,427,653	74.99
Work cars	1,506,762	184.11
Marine equipment	1,185,746	104.77
Shop machinery and tools	2,505,289	81.60
Conducting transportation : —		
Engine and roundhouse men	20,547,031	30.68
Fuel for locomotives	20,322,220	28.91
Train service	12,929,541	23.95
Station service	10,816,794	19.75
Switchmen, flagmen and watchmen	8,333,747	29.67
Superintendence	5,304,568	45.72
Salaries of general officers	615,013	6.84
Salaries of clerks and attendants	2,372,188	25.37
Total	$224,804,614	42.13
Total operating expenses	$248,203,915	36.77

These figures show the great increase in expenditures for equipment and structures. But it can hardly be concluded therefrom that there was a greater renewal of equipment than repairs on roadway. The items in maintenance of way are made up very largely of compensation paid to labor, while expenditures for renewal of equipment involve large payments for material and finished products. The higher prices,[1] then, for iron and steel, metals and lumber, made it

[1] In the fiscal year 1894–95 the index number of iron manufactures was 52; in 1899–1900 for the same group it was 89. For the group of minerals, metals and lumber in 1894–95 the index number was 92; in 1895–96 it was 89; in 1899–1900, 110 and even 115 in November and December, 1899.— (*Quarterly Bulletin, Bureau of Economic Research*, July and October, 1900.)

In the *Final Report of the Industrial Commission* (vol. xix), p.289, the great increase in the cost of material and supplies of 1900, as compared with 1897, is shown for 62 articles. The percentage increase in the price of some of the most important articles was as follows: Lubricating oil, 120; machine bolts, 150; steel axles, 131; track spikes, 135; nails, 109; coal, 44; sheet iron and steel, 48.

necessary to expend more in 1900 than in 1895 to renew or replace the same amount of equipment. It may be concluded that the volume of labor employed directly increased relatively more during this time than the volume or units of equipment maintained, though the amount expended for maintenance of equipment showed a greater increase than that for maintenance of way.

The full effect, however, of high prices in 1899 and 1900 should not be looked for in the expenditures of 1900. Much of the material used in 1900 was purchased a year or more earlier, and so at lower prices. Moreover, the large increase in the volume of new equipment during the years 1898-1900, much of which was not replacement, but an addition to the earning power of the property and consequently charged to capital account, did not require repairs during the first few years. The burden of repairing the equipment may be fully felt only within the next few years, so that in connection with high prices expenditures for maintenance of equipment may be expected to show a steady increase. Thus the expenditures for material and supplies may become increasingly more important than the increase in the direct employment of labor.

This tendency can perhaps be seen already by comparing the increase in the expenditures for maintenence of way and of equipment for several years. Thus, in 1895, 19.824 per cent of total classified operating expenses went to maintenance of way, and 21.797 per cent in 1900 went to the same source; and for the same years 15.761 per cent and 18.929 per cent, respectively, went to maintenance of equipment. This was an increase of 1.973 for maintenance of way and of 3.168 for equipment, or an increase almost two-thirds greater for equipment than for maintenance of way. The difference in the relative increase is more striking by taking 1898 for comparison. In this year maintenance of way was 21.028 per cent of total classified expenses, showing an increase for 1900 of .769; and maintenance of equip-

ment 17.359 per cent, an increase of 1.570. For these two years, then, the increase per cent of expenditures for equipment was twice that for maintenance of way. Conducting transportation consequently declined from 59.46 per cent of classified expenses in 1895 to 55.179 per cent in 1900.

Attention is usually called to the dependence of railways for their prosperity upon the general business conditions and the activity of other industries. But the importance of railway expenditures in sustaining or inducing business activity is too often overlooked. These expenditures are essentially cumulative and progressive in their influence, not only upon those industries producing railway supplies, but upon the railways themselves. The expenditure of one year contributes to an increase in the gross income of the next year, and makes possible a greater surplus to be expended a year later, so that each increase of the railway for material and supplies contributes, by the expansion in trade which it creates, to bring a greater increase for the next year. Since the amount runs into the hundred millions, the influence of railway consumption is a powerful stimulus to business prosperity.

The geographical distribution of this increase brings out the prominence of the Southern Mississippi and the Northwestern States (V, VI, VII), both in the total and in the several different sources of expenditure. In the retrenchment of 1894 the Northwestern States (VII) were first in magnitude, but in the increase they were exceeded by several other groups. The South Atlantic States (IV) and Texas (IX), where the smallest decrease had taken place, seem not to have been affected by this fact so far as an increase in expenditure upon the return of prosperity was concerned. Thus, in general, railways in the Mississippi Valley, which had suffered most during the depression, as shown by the retrenchments, made the greatest increase in operating expenses in time of prosperity. It

is safe to say that in this part of the country the most pronounced development of railways has taken place within recent years. This result can be traced to the activity of certain large railways operating in this part of the country.

PER CENT OF INCREASE IN OPERATING EXPENSES, 1900 OVER 1895 FOR SELECTED ROADS.

Groups.	Railway.	Total.	Maintenance of		Conducting Transportation.
			Way.	Equipment.	
IV, V . .	Southern	83.72	56.50	158.08	76.56
V, VI . .	Illinois Central	75.18	116.57	69.12	63.24
V, VI . .	Louisville & Nashville	52.01	59.26	63.17	42.83
V, VI . .	Mobile & Ohio	103.94	84.28	70.41	138.27
VI, VII, .	C. B. & Q.	60.45	106.16	134.20	38.93
VI, VII, X	Great Northern	62.91	87.82	71.50	51.94

INCREASE IN OPERATING EXPENSES, 1900 OVER 1895, BY GROUPS AND SOURCES OF EXPENDITURES.

Group.	Total Amount.	Total Per cent.	Maintenance of		Conducting Transportation. Per cent.	General Expenses. Per cent.
			Way. Per cent.	Equipment. Per cent.		
I	$10,547,762	18.59	23.29	32.54	14.76	1.81
II . . .	45,462,578	24.50	38.72	49.89	13.93	23.48
III . . .	37,727,934	32.46	57.60	68.66	18.02	2.71
IV . . .	8,872,768	31.06	40.68	61.99	21.16	1.22 [1]
V	24,612,173	46.27	47.70	71.49	41.28	25.78
VI . . .	58,306,080	45.93	82.89	80.79	30.54	4.41 [1]
VII . . .	9,893,023	41.69	68.93	71.99	28.00	12.58 [1]
VIII . .	20,361,815	33.39	29.09	58.10	30.36	17.86
IX . . .	7,279,823	21.66	16.78	29.89	22.82	10.02
X	12,644,140	31.41	21.52	53.60	31.61	20.95
Total . .	$235,708,096	32.48	46.70	59.22	22.72	9.53

[1] Decrease.

This increase in operating expenses cannot be explained by an increase in mileage, because the past decade was not prominent for railway construction. Increased traffic also is not sufficient explanation, though it may have made an addition to the expense necessary. The cost of operating a

railway does not increase in direct proportion to additional traffic handled. Thus the largest increase in traffic density was in Groups X and III (the Pacific States and Middle West), but other groups largely surpassed these in increased expenditures for operation. The capitalization per mile of line in these groups (X and III) was very high in 1900, so that a good physical condition of the roadway and of equipment had undoubtedly resulted from large capital expenditures. Because of this favorable condition of the property, doubtless less expenditure for maintenance was necessary. In the Southern Mississippi and Central Northwestern States (V and VI) the increase in operating expenses was very great, though the increase in mileage and in traffic density was only about the average. But here capitalization per mile of line in 1900 was very much below the average for the whole country. It is safe to say that the increase in

INCREASE PER CENT, 1900 OVER 1894, IN MILEAGE AND TRAFFIC DENSITY, AND RAILWAY CAPITAL PER MILE OF LINE, 1900.

Group.	Mileage.	Ton-Miles per Mile of Line.	Capital per Mile of Line.
I	6.3	39.7	$ 61,246
II	5.5	55.1	112,255
III	4.2	88.7	64,729
IV	10.8	79.5	57,684
V	8.9	55.1	42,707
VI	8.2	60.8	47,087
VII	7.5	65.4	51,952
VIII	9.0	50.1	60,324
IX	13.5	55.7	44,378
X	11.3	90.1	78,806
Total	8.2	60.8	$61,490

operating expenses of 1900 over 1895 was not the result of increased traffic handled, nor of new mileage put into operation, but depended more upon the physical condition of the property. This, at least, must be the explanation for Group V, where the railways have had poor road-bed and inefficient equipment. The replacement and renewal of this equipment

by heavier and more efficient rolling stock, made necessary large expenditures for maintenance of way. To bring the railways operating between the Ohio River and the Gulf up to the standard in efficiency is especially imperative, because of the competition that these roads are undertaking with the large trunk lines for much of the western produce, which they are seeking to carry to the Gulf ports for export, instead of permitting it all to go to Atlantic ports.

During this time the total amount of compensation paid to railway employees increased from $445,508,261 in 1895 to $577,264,841 in 1900, or 29.6 per cent. As between the different classes of employees the smallest increase went to general officers and the largest increase to other officers, though the increase of this latter class was only 2.5 per cent of the total increase. The other classes to receive greatly increased compensation were trackmen, other employees, carpenters and shopmen.

This increased compensation going to general classes of employees was not due to greatly increased wages. The rate of daily wages during the period of depression showed no marked decrease. The investigations of the Department of Labor[1] showed that for 25 occupations, taking the wages for 1891 as 100, the decline was only 1.9 per cent from 1893 to 1894, and for 192 occupations only 1.26 per cent. The index number of wages for conductors decreased 4.8 per cent; locomotive engineers, 5.3 per cent; and laborers, 3 per cent. The per cent increase, 1900 over 1895, of the index number for 192 occupations was 5.5 per cent. But rates of daily wages are inadequate by themselves to show the effect of depression or prosperity upon labor, because they neglect the quantity of employment. The rate of daily wages should be qualified by a coefficient of the amount of employment. But the railways, perhaps more than any other industry, furnish steady employment

[1] *Bulletin of the Department of Labor*, September, 1898, p. 668, and September, 1900, p. 914.

throughout the year to the men employed, so that the greater part of the saving in the pay-roll was accomplished by a reduction in the number of employees, and the increase in compensation was due not nearly so much to increased average wages as to a large increase in the number of men employed. The fact that average yearly compensation for all employees was exactly the same in 1900 as in 1895 seems to lead to the same conclusion.

This increase in the number of employees can be shown best by comparing the years 1900 and 1894. The total increase was 238,045, or 30.5 per cent. The employees in maintenance of way increased 50.8 per cent; 65 per cent of the total increase was due to the increase in maintenance of way and of equipment of 42 per cent.

INCREASE AND AVERAGE YEARLY COMPENSATION PAID RAILWAY EMPLOYEES, 1900 OVER 1895.

Classes.	Total Increase.		Average Yearly Compensation.	
	Amount.	Per cent.	1895.	1900.
General officers	$922,734	7.6	$2,262	$2,676
Other officers	3,286,676	67.7	1,915	1,744
General office clerks	4,306,269	22.9	708	717
Station agents	1,871,872	11.2	575	587
Other station agents	7,166,300	18.6	522	508
Enginemen	11,222,500	28.4	1,138	1,183
Firemen	6,632,466	29.4	635	661
Conductors	6,380,842	26.8	957	1,004
Other trainmen	8,340,340	22.9	582	604
Machinists	5,200,531	29.4	639	698
Carpenters	7,182,472	34.3	589	603
Other shopmen	14,732,264	32.9	504	519
Section foremen	1,745,891	10.5	561	558
Other trackmen	21,150,401	41.9	325	316
Switchmen, flagmen	5,344,989	22.0	562	582
Telegraph operators	2,561,090	18.8	648	641
All other employees	23,708,943	54.4	489	506
Total	$131,756,580	29.6	$567	$567

The contrast of the increase in the number of men engaged in maintenance and of those engaged in movement is shown

by the relative number in each class per 1000 employees. Thus the rate for transportation decreased 27 and for general administration 5, while for maintenance of equipment the number was the same for both years; and for maintenance of way the increase was 43. Maintenance of property in 1900 had thus assumed, judging from the distribution of employees per 1000, relatively greater importance than the mere movement of traffic. The reason for this is found in the increased efficiency of the men engaged in conducting transportation as a result of improved roadway and better equipment which made heavier trains possible.

Geographically the largest increase took place in the Pacific and the Southern Mississippi States (X, V). The largest reduction in 1894 had been in the Middle West and in the Central Northwest (III, VI), but, in view of the special conditions found in these groups, it is safe to say that the permanent force was reduced most largely in Texas and in the Southern Mississippi States (IX, V). In these groups the largest increase also took place, except in the Pacific States (X), so that the railways in these geographical divisions had increased in 1900 over 1894 the number of employees from three and one-half to four times the reduction that had been made in 1894. The Northwestern States (VII) also showed an increase that was four-fold the decrease. New England (I), in contrast to the rest of the country, had a rate of increase smaller than the reduction that had been effected in 1894.

A more detailed analysis shows that the principal increase had taken place in certain definite classes. Thus trackmen increased 50 per cent, which was 32 per cent of the total increase. Other employees increased 43 per cent, or 16.9 per cent of the total; and shopmen 36 per cent, or 12 per cent of the total. The class of other officers increased 162 per cent, but this made up only 1.2 per cent of the total. In contrast to this was the decrease in general officers, and the small rate for section foremen, station agents, machinists

and telegraph operators. Though the per cent increase in compensation was 29.6 per cent, and in the number of employees 30.5 per cent, it is important to note that the increase in the number of employees per 100 miles was only 19 per cent. This was an increase of less than 3 per cent over 1893 per 100 miles, while the absolute increase was

INCREASE IN NUMBER OF EMPLOYEES, 1900 OVER 1894.

Class of Work.	Increase.		Per cent of Total Increase.	Number per 1,000.		Increase.
	Number.	Per cent.		1894.	1900.	
Maintenance of way, etc. .	109,575	50.87	46.04	276	319	43
Maintenance of equipment	45,825	30.15	19.25	195	195	—
Conducting transportation	84,171	23.00	35.36	469	442	27 [1]
General administration .	4,702	14.81	1.97	41	36	5 [1]
Unclassified	6,228 [1]	42.59	2.62 [1]	19	8	11 [1]
Total	238,045	30.53	100.00	1,000	1,000	—
Maintenance: way, structures, and equipment . .	155,400	42.30	65.29	471	514	43

[1] Decrease.

INCREASE IN NUMBER OF EMPLOYEES BY GROUPS AND BY CLASS OF WORK, 1900 OVER 1894.

Group.	Total Number.	Total Per cent.	Maintenance of		Conducting Transportation. Per cent.	General Administration. Per cent.
			Way. Per cent.	Equipment. Per cent.		
I	6,366	10.93	16.23	2.01 [1]	12.46	10.15
II	38,690	18.52	29.24	22.56	13.83	.32
III	39,111	33.36	78.14	33.55	18.88	8.44 [1]
IV	6,965	17.81	1.50	66.51	6.49	62.69
V	29,747	51.13	48.83	52.97	54.76	37.11
VI	58,692	40.76	75.41	17.08	25.09	1.19
VII	9,657	40.44	123.74	133.76	98.17	116.12
VIII . . .	16,724	26.33	34.42	24.17	32.44	21.25
IX	13,357	42.73	67.65	45.19	31.91	52.81
X	18,736	53.42	62.13	57.69	40.02	63.63
Total . . .	238,045	30.53	50.87	30.15	23.00	14.81

[1] Decrease.

PROPORTIONATE INCREASE OF EMPLOYEES BY CLASSES, 1900 OVER 1894.

Classes.	Increase.		Per cent of Total Increase.
	Number.	Per cent.	
General officers	341 [1]	6.49 [1]	.14 [1]
Other officers	2,891	162.59	1.22
General office clerks	7,486	30.21	3.15
Station agents	3,411	12.10	1.43
Other station men	18,701	26.28	7.86
Enginemen	7,371	20.78	3.10
Firemen	7,803	21.50	3.28
Conductors	5,134	20.70	2.16
Other trainmen	10,857	17.12	4.56
Machinists	3,586	12.26	1.50
Carpenters	10,338	28.46	4.34
Other shopmen	30,414	36.06	12.78
Section foremen	3,425	11.55	1.44
Other trackmen	76,088	50.49	31.96
Switchmen, flagmen	7,570	17.52	3.17
Telegraph operators	3,073	13.90	1.29
All other employees	40,238	43.40	16.90
Total	238,045	30.53	100.00

[1] Decrease.

16.4 per cent. This indicates that the number of employees in proportion to the miles of railway increased less than one-fifth as much as the per cent of absolute increase. This taken in connection with the increase in traffic shows that the rate of increase in employment has really been very small, and that this itself may be due to the very large increase in several classes, notably among trackmen.[1]

Among the classes of the more skilled the number of men per 100 miles in 1900 had not reached the number of 1893. Thus in conducting transportation the number of men per 100 miles of line had actually decreased or remained at the same level. The only class to show any increase was the

[1] In 1893 the number of employees per 100 miles of line was 515; in 1894, 444; and in 1900, 529. There was thus an increase of 14 in 1900 over 1893. As between the several classes of employees, trackmen increased 12, other shopmen 5, while enginemen and firemen decreased 1 each, other trainmen 4, and machinists and carpenters each 1 in 1900 over 1893. With this large proportionate increase in trackmen and other shopmen the employees per 100 miles would have been less in 1900 than in 1893.

unskilled and a slight increase in general administration. Where improvements in machinery entered only slightly the relative amount of employment increased greatly over even the active year 1893, but so far as mere movement and work in the shops were concerned a smaller proportionate number of men were employed.

The special line of work in which the railways of different parts of the country have made most pronounced improvements is apparent from an examination by geographical

INCREASE PER CENT IN THE NUMBER OF EMPLOYEES BY GROUPS AND BY CLASSES, 1900 OVER 1894.

Class.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
General officers	28.8[1]	23.4[1]	19.2[1]	13.0	6.9	2.1	6.7[1]	13.8	13.7	29.0
Other officers	93.5	37.1	177.9	1,106.8	335.2	109.6	158.3	180.0	121.5	195.0
General office clerks	31.3	23.4	18.1	51.1	39.0	20.5	68.1	28.5	63.5	75.9
Station agents	5.2	18.4	4.2	8.3	25.5	8.0	6.7	14.5	18.7	14.0
Other station men	30.9	12.2	23.8	25.4	55.9	31.7	38.7	33.6	27.3	38.3
Enginemen	6.8	12.2	23.2	14.0	38.3	22.9	24.5	25.3	34.7	37.3
Firemen	4.1	15.4	24.4	11.8	34.0	22.0	30.6	28.8	40.1	32.3
Conductors	4.2	15.4	18.0	7.7	42.0	21.9	39.1	26.4	33.6	50.8
Other trainmen	3.6	8.1	22.4	3.4[1]	34.1	23.4	45.8	32.0	32.9	41.4
Machinists	8.3[1]	11.0	20.5	20.4	22.6	1.1	19.6[1]	28.3	32.1	49.4
Carpenters	8.6[1]	18.4	25.2	54.9	67.5	39.5	6.0	18.1	58.0	26.1
Other shopmen	14.3	30.8	46.3	90.7	52.5	24.8	13.1	26.3	19.7	80.3
Section foremen	12.7	12.3	10.5	1.9	25.3	2.7	10.7	13.8	19.1	28.3
Other trackmen	17.7	33.1	58.0	8.3	52.2	94.9	85.3	31.0	61.8	47.8
Switchmen, flagmen	1.3	12.5	14.0	10.6	48.1	22.8	25.0	19.1	23.7	47.3
Telegraph operators	22.4	3.7[1]	12.0	17.4	42.3	23.3	39.7	18.3	12.2	42.5
All other employees	.5	21.6	64.3	15.7[1]	103.6	77.5	47.9	21.7	59.5	86.9
Total	10.9	18.5	33.4	17.8	51.1	40.7	40.4	26.3	42.7	53.4

[1] Decrease.

divisions of the increase in the number of employees in different classes of labor. Thus in New England (I) the development took place in general administration and in maintenance of way, together with greater attention paid to station service. In the Middle States (II) the development has been among shopmen and trackmen, showing the policy of equipment and roadway improvement, and the growth of transportation service shown by the increase in enginemen

and conductors. This improvement of the roadway and equipment is also shown in the Middle West (III), and with it the increased service in movement made necessary by the great volume of traffic. Equipment, to the exclusion of nearly everything else, received the greatest attention in the South Atlantic States (IV), while in the Southern Mississippi States (V) attention was paid to roadway as well as to equipment. In the Northwest (VI, VII) the chief development was shown in roadway and in movement, and a smaller increase in betterment of equipment. In what may be called the Central West (VIII) is shown to have attended most to movement and roadway, administration and station service. Movement and roadway were the chief items in Texas (IX), and in the Pacific States (X) the largest increase was in men employed in the shops and in moving traffic. The department of general administration shows remarkable variations. The class of general officers increased only slightly in some of the groups, while in others there was a decrease. On the other hand, the class of other officers, though small in absolute numbers, increased out of all proportion to the other classes. This was due to the small number, so that a slight change was represented by a large percentage. The effect of consolidations also decreased the number of general officers and filled their places with other officers, or retained the same men who were then no longer classed as general officers.

This gives an idea of the particular departments of the transportation service which the railways of the different sections felt it important to improve, in order to increase the earning power of the property and to offer better service to the public.

The principal increase in expenditure and in employment was found to have been for maintenance and renewal of roadway and of equipment. The expenditures made for the movement of traffic increased in much smaller proportion, so that the number of men per 100 miles engaged in

movement was smaller in 1900 than in 1893. The effect of renewals and repairs can be shown by comparing the number of employees per 100 miles and the ton-miles representing the work accomplished. For this purpose the former period of prosperity represented by 1893 is compared with 1900.

Between these two years the increase per cent in the total number of employees per 100 miles of line was 2.7, but the increase in ton-miles per employee was 29.9 per cent. The increase in traffic handled was thus more than ten-fold the increase in the number of employees. Enginemen decreased 4 per cent per 100 miles, but the ton-miles per engineman increased 37 per cent. About the same relative proportions were shown by firemen. Other trainmen, however, decreased per 100 miles 9 per cent, but the ton-miles per man increased 48.6 per cent. This greater efficiency of trainmen would be shown more accurately if the men engaged in movement of freight were separately enumerated. The increased work performed by the handlers of freight is no doubt in many cases several hundred per cent greater than in 1893, as the result of the increased weight and high speed of freight trains, which have also shortened the hours of labor. This speed and carrying capacity are the result of the many improvements in equipment and betterment of roadway, much of which has been charged to operating expenses.

INCREASE PER CENT OF EMPLOYEES PER 100 MILES OF LINE AND OF TON-MILEAGE, 1900 OVER 1893.

Classes.	Per 100 Miles. Per cent.	Ton-Miles. Per cent.
All employees	2.7	29.9
Enginemen	4.3[1]	37.0
Firemen	4.2[1]	38.4
Conductors	0.0	38.9
Other trainmen	9.3[1]	48.6

[1] Decrease.

In view of these changes in expenditure and in employment, first by a reduction and then by a large increase, it

may be inquired as to the effects upon the safety of railway operation. A comparison thus of the fatalities among railway employees and coal miners may be taken as representing the degree of danger to which railway employees are exposed. In general railroading is found to be more dangerous than the mining of bituminous coal in Pennsylvania, but much less so than the mining of anthracite coal. Taking the total accidents in coal mining in comparison with those on the railways the period here covered naturally falls into two groups. From 1889 to 1893 inclusive, the fatal accidents per million employees on railways were proportionally higher than those in mining coal, and the years since 1893, during which time the accidents in mining coal have increased until they are considerably higher than the accidents on railways, changing place thus with the railways as to the dangerous nature of the occupation.

The largest proportion of fatal accidents occurred in 1891, and then slightly decreased to the year 1893, when a sudden drop followed in 1894. This low proportion continued in both mining and on the railways until 1899, when a rise began. The difficulty, however, with such a comparison on the basis of numbers alone is that the condition of business is not taken into account. Thus in considering the fatal accidents on the railways the density of traffic should be taken into account, and not alone the number of men employed. The danger on a railroad, it is reasonable to expect, other things being equal, increases largely in proportion as the traffic increases.

Thus taking the accidents in relation to the traffic density, it is shown that with an increase in traffic handled there was an increase in fatalities, except for the years 1896-99. With the falling off in traffic in 1894 the number of ton-miles per mile of line showed a decided increase per fatal accident, indicating a falling off in accidents. But with the increase in traffic beginning with 1896, the rate of fatalities seems not to have increased, but really to have de-

creased. The reason for this can partly be explained by the introduction of safety appliances on the greater number of cars and of signalling apparatus. The result of better equipment was that the men engaged in movement handled more freight per man, so that fewer men in proportion to the traffic were in a position to be exposed to the danger. Thus the traffic density in 1900 was 33.5 per cent greater than in 1893, but there were 42.5 per cent more ton-miles per mile of line to each accident during this time. This shows that the danger connected with the occupation did not increase by a considerable margin in the same proportion as the traffic handled.

FATAL ACCIDENTS TO EMPLOYEES, RAILWAYS AND COAL MINES, 1889-1900.

Year.	Pennsylvania Coal Mines.[1] Per Million Employees.			Railways.	
	Bituminous.	Anthracite.	Total.	Per Million Employees.	Ton-Miles per Mile of Line per Fatal Accident.
1889	1,888	3,226	2,557	2,815	227
1890	2,183	3,463	2,823	3,272	199
1891	3,183	3,463	3,323	3,392	189
1892	1,688	3,051	2,369	3,110	213
1893	1,640	3,224	2,432	3,123	202
1894	1,441	3,144	2,292	2,341	250
1895	1,825	2,939	2,377	2,307	265
1896	2,136	2,354	2,245	2,253	281
1897	1,723	2,836	2,279	2,069	306
1898	2,255	2,886	2,570	2,240	315
1899	2,821	3,286	3,053	2,382	298
1900	2,513	2,859	2,686	2,508	288

[1] Pennsylvania Bureau of Mines, Report of 1899, pp. x, xiv; 1900, pp. xxxiii, xxxv.

With the prostration of business in 1894 and the consequent decline in railway earnings, the chief retrenchment in operating expenses was effected in the maintenance departments which furnished more than one-half the reduction and more than two-thirds of the labor discharged. The effect must have been a failure to make the necessary re-

pairs and renewals to meet ordinary deterioration. Such reductions consequently were not real retrenchments, but the saving thus made was merely temporary and was really borrowing capital invested in the property. If the earning capacity of the plant as a whole was not permanently to be impaired, such a loan had to be returned to the property at some early period.

The return of prosperity brought greatly increased earnings, a large part of which were expended for operation. Though much of these increased expenditures were necessary because of the growth of business, the larger part were evidently not necessary to handle the existing traffic. They were also not made only for the purpose of bringing the railways up to the standard of the former period of prosperity, but greatly to improve transportation facilities in order to handle traffic with the greatest economy. It was thus that a system of real retrenchment was in progress, so that the efficiency of labor engaged in movement was greatly increased over former prosperous times, while the danger of the occupation even decreased. The economies suddenly forced upon managers by the depression of 1894–97 may in this way have been made permanent.

REVIEWS AND MISCELLANY.

NOTES ON VITAL STATISTICS.

Defects in British Census-taking.

A short paper by Dr. J. R. Kaye on the "Certification and Registration of Death," in *Public Health* for October, 1901, criticises the British system of collecting mortality statistics in the following respects. The Registration Act of 1874, which is still in force, requires a certificate of death from all medical men in attendance upon deceased persons and from coroners in all cases of sudden, violent and suspicious deaths. Although this act greatly improved the conditions which obtained under the system of voluntary medical certification in operation since 1837, it left unaccounted for a certain proportion of deaths which occur without medical care or coroner's inquest. The ratio of these uncertified deaths is decreasing steadily, having fallen from 4.1 per cent in 1881 to 1.85 per cent in 1899; but the error is still unfortunate. The second flaw in the registration system is the lack of medical certificates of still births, the certificate of any midwife being accepted for the burial of still-born children. The third source of error in the mortality statistics arises from the imperfect returns of the causes of deaths by medical men and, still more, by coroners. The use of such vague terms as catarrh, senile decay, asphyxia, etc., the reporting of several causes for a single death, without indicating their relative importance, and the deliberate suppression of such causes as alcoholism and syphilis, are mentioned in particular. Dr. Kaye quotes the recent verdict of a coroner in Leeds, which was "death from strangulation, but no evidence to show the child had ever lived." He urges the medical certification of deaths, including still-births, on a compulsory form of certificate, and the investigation by a public official of all deaths not so certified.

A companion paper to that just reviewed is a criticism of the British census system entitled "The Case for Census Reform," published by G. H. Ryan in the *Journal of the Institute of Actuaries* for January, 1902. The author quotes extensively from the Report of

the Census Committee appointed by the Government in 1890, as well as from other sources, and comments on existing conditions with some severity. His first point is the need for a quinquennial census in order to furnish data for sanitary and financial calculations in the smaller registration districts, where changes in the rate of increase make deductions from the ten-year census untrustworthy. He points out that the more progressive nations, France, Germany, Sweden, and some of the Australian colonies have already adopted the more frequent census. Mr. Ryan's next argument, for a permanent census office, sounds somewhat familiar to Americans at this time; but it is pleasant to find that the generous equipment of the American census bureau and the employment of expert assistance of high character are quoted as examples for the British government. In connection with the presentation of the data collected the omission of the returns of the population at integral years of age (quinquennial totals only being given from 5 years to 25 years, and decennial totals from 25 to 85), is justly criticised. Finally the author strongly urges the examination of the Hollerith Electrical Tabulating Machine used in Russia and the United States, in connection with recent censuses. Anyone interested in this machine will find an interesting account of its work in a paper on "Mechanical Tabulation of the Statistics of Agriculture in the Twelfth Census of the United States," read by H. T. Newcomb before the American Association for the Advancement of Science at Denver in August, 1901, and since published in pamphlet form.

The Canadian Census.

The *Economic Journal* for December, 1901, contains a review of the recent Canadian census by Professor John Davidson, of the University of New Brunswick. The author notes the widespread popular disappointment over the reduced rate of increase during the last decade (nine per cent, against eleven per cent in the previous decade). He believes, however, that the exodus to the United States which has held the Dominion population down has already begun to be balanced by an influx of Americans to take up Canadian lands. An analysis of the figures shows that while Prince Edward Island has actually lost in population, and Nova Scotia, New Brunswick and Ontario have increased but slightly, British Columbia has nearly doubled,

and the Northwest Territories have more than doubled their totals. Besides the gross population, the number of families and the number of dwellings in the various districts have been already published. The number of persons to a family shows a slight decrease, from 5.2 to 5.1, for the whole Dominion; the 1901 value in the eight provinces ranges from 4.5 in Ontario to 5.5 in Prince Edward Island.

The Law of Averages in Criminology.

In *L'Economiste Français* for October 26, 1901, is an interesting summary of the report of the Keeper of Seals on the crimes and misdemeanors in the French Republic during the year 1899. Crimes against the person occurred in the same number as in 1898; but crimes against property showed a marked augmentation, due to an increase of thirteen per cent in grand larceny and an increase of twenty per cent in incendiarism. The classification of the criminals according to sex, age, and civil and social condition gives results almost identical with those of the preceding year, and exhibits in a very striking manner the constancy of the sociological laws controlling crime.

Classes of accused persons.	Percentage of all accused persons.		Classes of accused persons.	Percentage of all accused persons.	
	1899	1898		1899	1898
Sex :			Birth :		
Males	86	83	French	93	94
Females	14	17	Foreign	7	6
Age :			Domicile :		
Under 21 years	19	18	Rural	36	37
21–40	55	56	Urban	49	49
41–60	21	22	None	15	14
Over 60 years	5	4	Literacy :		
Civil Condition :			Completely illiterate	15	13
Single	60	59	Able to read and write	82	83
Married	34	35	Having superior education	3	4
Widowed	6	6			

The misdemeanors show a marked falling off in arrests for vagabondage and mendicancy, due to a ministerial circular of May 2, 1899, urging leniency toward offenders of this class, and a decrease in simple theft, with an increase in assault and battery.

Mental Pathology and Alcoholism.

A paper on *Idiot and Imbecile Children*, published by Dr. Louise G. Robinovitch in the *Journal of Mental Pathology*, for July, 1901, p. 86, contains a table of statistics with regard to 100 idiotic and imbecile children admitted to the Ste. Anne Asylum, Paris. In the families of these 100 children, 155 other children had been born, of whom 53 had died and 7 miscarried, while 95 were living at home, of whom 72 only were in good health. In the 100 families, both parents were "alcoholic" in one case, the mother was "alcoholic" in one case and the father in 52 cases. The author concludes that "Alcoholism of the parents not only causes idiocy and imbecility of the offspring, but also acts as a strong factor in reducing the birth rate and increasing the death rate." This may be true, but it requires other proof than the statistics quoted. In the first place, the term "alcoholic" is indefinite; according to some definitions, fifty per cent of non-idiotic children of the poorer classes might show 54 per cent of "alcoholic" parents. In the second place, alcoholism is associated with poverty and poverty with poor food, bad air, etc., so that any relation which exists may be an indirect one. Finally, according to biological theories of heredity, the alcoholism of the parent may not cause the idiocy of the child, but both may be the results of defect in the original germ plasm from which both child and parent are derived.

A paper by Dr. J. Morel in the *Journal of Mental Pathology* for September, 1901, contains some similar statistics on the contributory causes of pauperism and crime under the caption, "On the Prophylaxis and Treatment of the Recidivist Criminal." It seems reasonable to suppose that the laws of criminology can best be studied in the class of persons mentioned, as the character of the occasional criminal should be intensified in the habitual offender. Dr. Morel gives the statistics of 158 recidivists sentenced for ten or more years; of this number, 55 had "alcoholic" parents, 37 had members of their family serving sentences, 30 had no education, and 52 had only rudimentary education. Again, the lack of comparative figures for the non-criminal population of the same social rank and the vague nature of the basal information (except in the case of relatives under sentence), make any conclusions hazardous.

Vital Statistics of France for 1900.

An official report on the movement of population in France during 1900 is published in the *Journal de la Société de Statistique de Paris* for January, 1902. The discouraging conclusions as to decreasing population drawn from the last census are confirmed by this document. The total number of births fell in 1900 to 2.24 per 100 of the legal population, the lowest figure recorded since the beginning of the century. The most hopeful feature of the report consists in an increased marriage rate, the figure, 1.54 newly married persons per 100 population, being higher than any which has been noted since 1876.

A New Theory to Account for Decreasing Birth Rates.

M. G. Cauderlier contributes a striking and important paper on "La Loi qui règle les Naissances" to the *Journal de la Société de Statistique de Paris* for January and February. His thesis is that the birth rate, like the marriage rate, is directly controlled by economic conditions, in particular as such conditions affect emigration; and he takes issue with Bertillon, Leroy-Beaulieu and Arsène Dumont, who hold the main factor to be the complexity of civilization, and the increase of social ambition. Cauderlier first takes up the successive changes in various European countries, and shows that, while in general the natality rate rose from 1840 to 1875 and fell from 1875 to 1895, the fecundity rate was much more constant. In England and Belgium it remained stationary; in France it fell from 1867 to 1872, in consequence of the antagonism with Prussia and the war of 1870, and again from 1884 to 1889 in consequence of the invasion of the phylloxera and financial crises; in Wurtemburg it fell from 1864 to 1870, thanks to three wars and the heavy expenses connected with the formation of the German Empire; in Holland it remained constant from 1857 to 1878, and then rose till 1885, corresponding with an enormous increase in foreign trade; in Prussia it remained constant from 1859 to 1883, and then rose with the rapid development of industry and commerce. The author concludes, therefore, that the fecundity is constant for the same region, except for economic changes. M. Cauderlier then considers the geographical difference in the birth rate in various parts of Europe. The maximum is found in the most

fertile and industrial regions of Russia, and the ratio of births decreases in proportion as one passes from this center.

Assuming the normal fecundity to be a constant, the author explains a decreased natality in various regions, such as Belgium, England and France, by a combination of the five following factors, — a decrease in the number of marriages, an improvement in sanitation, tending to increase the proportion of the population below marriageable age, an increase in the mean age of marriage, an increased centralization of population in cities, where "the natural coefficients of fecundity" are diminished, and poor economic conditions directly decreasing fecundity. The next section of M. Cauderlier's paper deals with the periodic variations in fecundity in the various departments of France, and shows a marked relation between this value and economic conditions. Most striking, however, is his tabulation of the illegitimate fecundity (ratio of illegitimate children to single women), a quantity which would naturally be freer from the effect of increased restraint during periods of financial depression than any of the rates ordinarily used. In spite of this fact the relation to economic conditions is marked as, shown by the following table: —

Period.	Conditions.	Number of Departments with Illegitimate Fecundity Rate		
		Increasing by over 5 per 10,000	Stationary.	Decreasing by over 5 per 10,000
1852–56 to 1857–61 . .	Prosperity .	44	22	15
1857–61 to 1862–66 . .	Prosperity .	37	24	20
1862–66 to 1867–71 . .	Panic . . .	21	20	43
1867–71 to 1872–76 . .	Prosperity .	32	29	23
1872–76 to 1877–81 . .	Panic . . .	15	23	46
1877–81 to 1882–86 . .	Slow recovery	41	19	24
1882–86 to 1887–91 . .	Panic . . .	19	24	41
1887–91 to 1892–96 . .	Slow r covery	42	26	16

Having thus shown that the restraint of parents is insufficient to account for all the facts, the author studies the various departments in detail in order to find some other cause. He shows that they may be divided into five groups — those in which the fecundity has not varied since 1857; those in which the fecundity showed a fall

due to the war of 1870–71, but was constant before that period, and has been constant at a lower level since; those in which the economic conditions following the war proved beneficial and which show a constantly higher rate afterward than before; those in which a constant rate before the war has been replaced by a steadily falling one; and those in which the fecundity has been steadily decreasing since 1857. The last two classes of departments must furnish, of course, the key to the situation. M. Cauderlier studies in each of them the ratio of males between the ages of 15 and 20 to the number between 25 and 30, and shows that there exists a constant difference between the two age groups far too great to be accounted for by any ordinary mortality, and pointing clearly to an active emigration of young men. For example, in the extreme case of the department of Landes there were in 1891, 16,624 males of the first age group and 7357 of the second. The author believes, then, that the decreased fecundity is mainly due to the removal from the rural districts of a large proportion of young men, including the most vigorous, active and healthy individuals. This operates, not only directly by the removal of young husbands, but indirectly by a reversal of the process of natural selection, leads to a constant deterioration of the race with a corresponding fall in the rate of fecundity. The introduction of this biological factor to explain a declining birth rate is a new and significant contribution to the problem. At the same time it appears to the reviewer that the truth lies somewhere between the positions occupied by M. Arsène Dumont and M. Cauderlier, — for this reason: Emigration to the cities accounts for a decreased fecundity in rural districts, but it does not account for the decreasing population of France, as a whole. Why is not the emigration of the strongest young males from the country to the city followed by an increased urban fecundity sufficient to balance the rural decrease? Not because the purely biological conditions of city life favor a low birth rate, for the reverse is the case. As M. Cauderlier himself says, "*la faible natalité des grandes villes est due à ce que ces dernières augmentent les besoins de la vie, en fournissant les moyens d'y satisfaire.*" That is, the author is after all compelled to call in the factor of self-restraint, due to the complex needs of civilization, to account for the larger features of the problem. Nevertheless, this paper, like all M. Cau-

derlier's work, is admirably thorough and scientific, and his recognition of biological laws is most important. No one has contributed more ably than this author to the progress of vital statistics during the last few years.

C.-E. A. WINSLOW.

STATISTICS OF DISEASES.

Statistics of Typhoid Epidemics.

Dr. Schüder, of Koch's laboratory at Berlin, attempts a statistical estimate of the relative importance of various vehicles of typhoid infection in a paper, "Zur Aetiologie des Typhus," in the *Zeitschrift für Hygiene und Infectionskrankheiten*, vol. xxxviii, p. 343. He has collected reports of epidemics of various size, and by including 12 single cases where personal contagion was excluded, brings up his total to 650. Of these, 377 were in Germany, 140 in England, 66 in France, and 25 in America. Tabulating the epidemics by assigned causes, it appears that 70.8 per cent were supposed to be due to water supply, 17.0 per cent to milk supply, and 3.5 per cent to other foods. The value of such a massing of incongruous statistics in which large and small epidemics are given equal weight, may fairly be doubted. It is also quite impossible to apply laws derived from the study of epidemics to the distribution of a disease as a whole. Besides sharp epidemic outbreaks arising from the transmission of infection to a large number of people at the same time by the same medium, typhoid fever is propagated more insidiously, in a fashion for which the reviewer has elsewhere suggested the term "prosodemic," passing from person to person by different routes of infection. Obviously water supply furnishes an exceptional opportunity for the first mode of infection, and will be of much less importance in the second.

Diphtheria Statistics.

Some valuable diphtheria statistics, "Diphtherie–statistik des Stadtkrankenhauses zu Dresden 1849–1898," are published by Dr. F. Förster as a *Sonderabdruck aus der Festschrift zum fünfzigjährigen Bestehen des Stadtkrankenhauses zu Dresden.* The table of monthly

distribution of cases exhibits the usual relations, as shown by the following summary :

CASES OF DIPHTHERIA ADMITTED TO THE DRESDEN CITY HOSPITAL, 1849–98.

January	210	July	124
February	143	August	89
March	157	September	171
April	133	October	169
May	143	November	194
June	127	December	177

During the period 1849–94 there were 1403 cases of diphtheria with 316 deaths, a fatality rate of 22.5 per cent. The first injection of anti-toxin was on September 5, 1894 ; and in the four years, 1895–98, there have been 434 cases and 35 deaths, a rate of 8.1 per cent. It would be perhaps fair to compare the rate for 1895–98 with that for the corresponding period immediately preceding. It appears from Dr. Förster's table that there were 336 cases and 115 deaths in the four years, 1891–94, giving a rate of 34.2 per cent, which makes the results of the anti-toxin treatment still more striking.

Trichinosis in Germany.

Bulletin No. 30 of the Bureau of Animal Industry, U. S. Department of Agriculture, is entitled "Trichinosis in Germany," and includes a very elaborate analysis of the German statistics of this disease. The principal part of the report by Dr. C. W. Stiles is devoted to a detailed review of individual cases on record during the period 1881–98. The first fact brought out is a steady decrease in the prevalence of trichinosis, due to the education of the public and the official inspection of pork products ; and not at all connected with the importation or non-importation of American meat. The following compiled table shows the main facts : —

Period.	American Pork.	Cases of Trichinosis.	Deaths.	Cases per Annum.
1881-82	Admitted.	1,193	17	596
1883-91	Excluded.	4,093	274	455
1892-98	Admitted.	1,043	27	149

The second point emphasized is that of the 6329 cases recorded between 1881 and 1898, 3388 were traced to pork, which had

passed the usual microscopic inspection, and in only 874 cases was it definitely shown that uninspected meat was the cause. Thus it appears that even the elaborate German system furnishes no absolute safeguard against trichinosis.

Vaccination Statistics.

In the discussion of a paper, by Dr. J. F. J. Sykes, on "Small-pox in London," published in *Public Health* for January, 1902, is a table of vaccination statistics furnished by Dr. W. A. Bond, which is worth citing. It furnishes a comparison of the fatality among the vaccinated and unvaccinated in certain large English towns, and, assuming that it is correctly compiled, furnishes valuable evidence of the protective effect of vaccination. It is free from the error introduced by a too strict interpretation of what constitutes a successful vaccination, as it is stated that the "vaccinated include all cases that had *any* evidence of vaccination." In the second place the age limit is a useful one, as it makes it unnecessary to consider the lapse of time since vaccination was effected. In the subjoined table the figures for the smaller towns given by Dr. Bond are omitted: —

SMALL-POX IN PERSONS UNDER TEN YEARS OF AGE.

Town.	Period.	Vaccinated.			Unvaccinated.		
		Cases.	Deaths.	Rate.	Cases.	Deaths.	Rate.
London	1891-1900	125	0	0.0	672	153	22.8
Sheffield	1887-88	353	6	1.7	228	100	43.9
Dewsbury Union . .	1891-92	44	1	2.2	174	56	32.1
Warrington	1892-93	33	2	6.0	32	12	37.5
Gloucester	1892-93	26	1	3.8	680	279	41.0
Manchester	1892-93	11	0	0.0	36	7	19.4
Bradford	1893	17	0	0.0	57	23	40.3

Prevalence of Phthisis.

Dr. W. H. Symons discusses "The Distribution of Phthisis," in *Public Health*, for March, 1902, and suggests several interesting questions. He first tabulates the mortality in England by counties for the periods 1861–70 and 1892–99, showing widely variable rates, with a pretty constant decrease, when the two periods are compared. Thus the highest rates in the second period are in London, 177 per 100,000

population, a decrease of 62.3 per cent; Northumberland, 172 per 100,000, a decrease of 69.1 per cent; and Lancashire, 149, a decrease of 53.1 per cent. The lowest rates are in Rutland, 78 per 100,000, a decrease of 41.3 per cent; Westmoreland, 89 per 100,000, a decrease of 36.4 per cent; and Monmouthshire, 99 per 100,000, a decrease of 47.6. The relation between the sexes in the various counties varies markedly. For England and Wales the male rate in 1895–99 was 153 per 100,000, and the female rate, 115; in London the male rate was 225 and the female rate 132; and for Warwickshire the figures were 172 and 99. On the other hand, in Lincolnshire, Cumberland, Dorset, Monmouthshire, and South Wales the female death rate exceeded that recorded for males. Finally, Dr. Symons gives some statistics of the house-to-house distribution of tuberculosis in the city of Bath, showing the greater incidence in certain houses, to be expected from the infectious character of the disease.

C.-E. A. WINSLOW.

RECENT SANITARY REPORTS.

Common Fallacies in Municipal Statistics.

The *Twenty-fourth Annual Report of the Health Commissioner of the city of St. Louis*, for the year ending March 31, 1901, is a bulky document containing considerable statistical material. Although the total number of deaths in 1900 was 175 less than in 1899, the death rate calculated on the census population of 575,200 was 17.1, against 15.4 in 1899, calculated on an estimated population of 647,000. It is stated in a foot-note that "The figures of population given above appear in a number of instances — except those for the United States census years — to be little more than guess work, and the mortality percentage based upon them open to question." This is true for many other cities whose officials are less frank than those of St. Louis. The Commissioner brings out one important point in connection with tuberculosis, as follows: "It is well known that a large proportion of the poor of our city carry a small life insurance policy, generally just enough to provide for funeral expenses. If tuberculosis be ascribed as the cause of death, the policies in many of these companies

are wholly, or in part, vitiated; it is at once apparent how important the word 'tuberculosis' becomes to many people. Attempts to influence physicians, even by direct bribes, not to use the word 'tuberculosis' in the death certificate are of common occurrence; the potent argument of 'no insurance, no doctor's fees' is sufficient to prompt the majority of physicians to find other causes of death." The antitoxin statistics are important, but, as in the case of many other cities, they suggest one question. In the six years, 1889–94, there were in St. Louis 5716 cases of diphtheria and croup, and 2027 deaths, giving a fatality of 35.46 per cent; in the six years, 1895–1900, there were 13,593 cases and 2131 deaths, with a rate of 15.67 per cent. That is, the reduced fatality rate is accompanied as in many other cities where, approximately these two periods have been compared, by a great increase in the number of reported cases. Without in any way questioning the general fact of a great reduction of fatality, due to antitoxin, it seems probable to the reviewer that a certain part of this increase in reported cases is not real, but is caused by a greater anxiety to report the disease and secure the benefits of the new treatment. Of much more significance than the general fatality rate is the ratio of only 8.78 deaths to 100 cases among the 2347 persons known to have been treated with antitoxin, furnished by the health department itself, during the last period. This is very striking. The latter part of the report contains a large amount of material which is scarcely worth printing in detail. The analysis of all the individual causes of death, by months and ages, the tables of decedents received from outside the city, the elaborate tables of cases treated at the city dispensary, the city hospital, the insane asylum and the female hospital would be accessible to all who might care to consult them if kept on file at the health office, and they unnecessarily cumber the printed report.

Zymotic Diseases and the School Term.

The *Annual Report of the Board of Health of Cambridge, Mass.*, for 1901 contains, as usual, a model presentation of the statistics of the zymotic diseases. The estimate of population upon which the rates are calculated is obtained, as stated, from the State Board of Health. It would be of great service in increasing the comparability of vital statistics if sanitary authorities in general would thus refer their population estimates to the State boards. The tables of reported

cases of the infectious diseases by weeks are valuable. The following table, extracted from two of those in the report, indicates the effect of the opening of the school term on diphtheria and measles: —

	Week ending —							
	Aug. 3.	Aug. 10.	Aug. 17.	Aug. 24.	Aug. 31.	Sept. 7.	Sept. 14.	Sept. 21.
Cases of Diphtheria	15	9	3	3	7	5	3	2
Cases of Measles	4	0	2	0	0	0	0	0

	Week ending —							
	Sept. 28.	Oct. 5.	Oct. 12.	Oct. 19.	Oct. 26.	Nov. 2.	Nov. 9.	Nov. 16.	Nov. 23.
Cases of Diphtheria	5	9	18	10	19	15	15	14	14
Cases of Measles	0	1	8	2	11	7	12	7	3

The fact that the number of scarlet fever cases reported per 1000 population was 1.07 in 1901 against 1.91 in 1900, while the fatality rate rose from 5.11 to 7.91, and the fact that the number of cases of diphtheria reported fell from 10.00 to 6.53 per 1000, while the fatality rate rose from 7.78 to 9.59, apparently indicates more imperfect reporting in 1901 than in 1900.

The *Twelfth Annual Report of the Board of Health of the City of Fitchburg, Mass.*, for 1901, is a somewhat less modern document than the one just reviewed. Valuable tables are given showing the monthly prevalence of diphtheria, scarlet fever, and typhoid fever for twelve years, which again bring out the fall increase usually attributed to school contagion.

Reported Cases of Scarlet Fever and Diphtheria in Fitchburg, 1890-91.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Scarlet Fever	52	70	56	70	56	36	34	31	34	63	66	56
Diphtheria	34	32	22	35	33	15	23	11	39	55	76	46

The tables following, in which the quarterly percentages of the annual totals of these diseases are calculated out to the second place of decimals, are not very significant. The wisdom of devoting three pages of text and tables to the proportion of houses in which cases of infectious disease occurred, in which the plumbing was defective, may reasonably be doubted, in view of the well-known fact, recently expressed by Mr. A. L. Webster, when he said that, in his opinion, fully 80 per cent of all the houses in New York would show defective plumbing, if severely tested. The usual old-time graphic chart of the principal causes of death is given, with the zymotic diseases (cholera infantum, "membranous croup," typhoid fever, diphtheria, and "la grippe") in red, and the other diseases (including pneumonia, consumption, peritonitis, gastro-enteritis, septicæmia, and diarrhœa) in black. The causes of death which rank fourth and fifth in importance are infantile debility and senile debility, indicating great carelessness in the returns of mortality.

Typhoid Fever and Polluted Water.

The *Annual Report of the Department of Health of Newark, N. J.*, for 1900, contains a significant table of the typhoid fever death rate in Newark and Jersey City in connection with the water supply of those cities.

TYPHOID FEVER DEATHS PER 100,000 INHABITANTS.

Year.	Jersey City.	Water Supply.	Newark.	Water Supply.
1889	——	A	90.0	A
1890	90.8	A	62.8	A
1891	94.5	A	96.4	A
1892	52.4	A	42.1	B
1893	59.8	A	22.2	B
1894	66.1	A	16.6	B
1895	73.6	A	23.1	B
1896	60.9	A and B	20.9	B
1897	21.4	B and C	14.4	B
1898	36.3	B and C	13.2	B
1899	15.0	B and C	27.5	B
1900	21.3	D	20.0	B

A = Passaic River at Belleville (below Paterson and Passaic).
B = Pequannock River.
C = Passaic River at Paterson Falls (above Paterson and Passaic).
D = " " " Little " " " " " "

A Triumph of Sanitation.

The *Report of Vital Statistics of the city of Havana*, for the year 1901, made to the military governor by Major W. C. Gorgas, surgeon, U. S. A., and chief sanitary officer, is one of the few fruits of the Spanish War of which Americans can afford to feel proud. The splendid sanitary work of the United States army in Cuba and Porto Rico forms a bright contrast to the unfortunate conditions in the Asiatic islands. The present report gives evidence of one of the most remarkable revolutions ever effected in the history of sanitary science. The general death rate for the city in 1901 is given as 22 11, a very creditable one. It is hardly fair, however, to compare this rate, as Major Gorgas does in one place, with the war rate of 1898, which was 91.03; or, as he does in another place, with the average of the thirty-one years, 1870–1900, which was 41.95. Between 1882 and 1896 the death rate was only once over 37, and its usual range was between that figure and 29. This would be a fairer basis for comparison, and even this shows a decrease of one-third in total deaths. The race distribution of births and deaths exhibits one curious feature, the low birth rate among the colored population, only 13.67 per thousand, against 23.78 for the whites. The result, in combination with a slightly higher death rate for the colored population, is a net excess of deaths over births in that section of the community amounting to 513, while the native whites have increased by 1740. As regards the infectious disease it appears that an encouraging decrease has taken place since the beginning of the American occupation, as may be seen from the following table: —

Deaths from Certain Zymotic Diseases, 1892-1901.

	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
Tuberculosis . . .	1,528	1,342	1,314	1,623	1,578	1,926	2,794	981	851	900
Malaria	202	240	201	206	450	811	1,907	909	344	151
Typhoid Fever . . .	366	208	100	183	487	679	1,012	140	90	83
Diphtheria, Croup .	84	147	76	25	19	36	23	39	15	25
Small-pox	0	8	216	181	1,004	1,404	168	4	2	0

It should here be noted again, that the amount of disease during the three years, 1896–98, was greatly in excess of the normal. It is evident, however, that the deaths from typhoid fever and tuber-

culosis have been sensibly decreased, as compared with the period prior to 1896. Small-pox was absent from the city, as it is today, in 1885 and 1886, and again in 1892, between sharp epidemic outbreaks. The great triumph of the army surgeons has, however, been in the fight against yellow fever. This disease has been a scourge of Havana for over two hundred years, and the tables published in the report show that during the period, 1856–1900, it caused an average of 751 deaths a year; the maximum, in 1857, was 2058; the minimum, in 1866, 51. Sanitary improvements, up to 1900, had made some difference in its prevalence, but in that year the yellow-fever deaths amounted to 310. The brilliant and devoted work of Dr. Reed, Dr. Carroll, and Dr. Agramonte showed at this time that the bite of a certain mosquito was the means, and, probably, the only means by which this disease could be transmitted. March 1, 1901, an active campaign against the mosquito was begun, involving the inspection by the "Stegomyia Brigade" of 119,537 houses. The result has been that there have occurred between March 1, 1901, and Feb. 15, 1902, only 6 deaths from yellow fever; there has not been a case in the city since Sept. 28, 1901. The records for the last five years will give a fair idea of what this really means.

DEATHS FROM YELLOW FEVER IN HAVANA.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1897 . .	69	24	30	71	88	174	168	102	56	42	26	8
1898 . .	7	1	2	1	4	3	16	16	34	26	13	13
1899 . .	1	0	1	2	0	1	2	13	18	25	18	22
1900 . .	8	9	4	0	2	8	30	49	52	74	54	20
1901 . .	7	5	1	0	0	0	1	2	2	0	0	0

It may be noted that this wonderful triumph of sanitation was made possible, not only by vivisection, but by human vivisection, the demonstration that the mosquitoes really carried the disease being made by allowing them to bite non-immune persons who volunteered for the experiment.

C.-E. A. WINSLOW.

MORTALITY STATISTICS OF ITALY.

Statistica delle Cause di Morte Nell' Anno 1899. Roma, 1901.

This summary of the mortality statistics of Italy for 1899 is issued by the Minister of Agriculture, Industry and Commerce. The population employed as a basis of estimate is that of June 30, 1899, which is estimated to have been 32,112,900. (The census population of Feb., 1901, was 32,450,750). The total number of deaths in 1899 was 703,393, which was equivalent to a death rate of 21.9, being the lowest death rate recorded since the system of accurate records was established. The highest death rate was 28.1 per 1000 in 1887.

The deaths of males were 355,654, and those of females were 347,739.

The explanation of the decided fall in the death rate is to be found in the tables of causes of death, and shows that the decrease is mainly in the class of infectious diseases.

The following figures for the years 1887 and 1899 are selected from the tables, the relative figures being given as more significant than the absolute figures :—

DEATH RATES PER MILLION INHABITANTS, ITALY, 1877 AND 1899.

Causes of Deaths.	1887.	1899.	Causes of Deaths.	1887.	1889.
Small-Pox	550	7	Puerperal Fever	85	41
Measles	806	231	Cancer	428	519
Scarlet Fever	496	140	Apoplexy and Paralysis	1,124	1,132
Diphtheria	956	515	Bronchitis	2,165	1,824
Whooping Cough	378	246	Pneumonia	2,163	2,247
Influenza	18	133	Heart Disease	1,366	1,643
Malarial Fever	713	337	Diarrheal Diseases	3,372	2,961
Erysipelas	178	93	Kidney Diseases	256	399
Syphilis	64	73	*Violence* (Accidents)	379	319
Rabies	3	2	Homicidal	52	44
Pulmonary Tuberculosis	1,078	1,092	Suicidal	49	63
Tabes mesenterica	462	273			

By the foregoing table it appears that the decrease in the mortality from infectious diseases much more than counterbalances the increase in the so-called local diseases. The same observation is

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true of most countries in which the mortality has been recorded in the same periods.

The deaths of infants under one year were 168,244, or 23.9 per cent of the total mortality. The principal causes of infantile mortality were debility, diarrheal diseases, acute bronchitis and convulsions.

The deaths from violence are carefully classified by causes, ages, sex, seasons, and conjugal conditions. The accidental and homicidal deaths had slightly diminished, comparing the first three years, 1887, 1888 and 1889, with the last three years, 1897, 1898 and 1899, and the suicides had increased. The principal modes of death by accident were drowning, falls and burning, these three modes constituting two-thirds of the accidental deaths.

The accidental deaths from poisoning in 1899 were 158, of which 18 were by mushrooms, 13 by corrosive sublimate, 16 by sulphuric acid, and 18 by the bites of snakes and other poisonous animals. The principal poisons used for suicidal purposes were corrosive sublimate, sulphuric acid, phosphorus, strychnine, sulphate of copper and arsenic.

Of each 1000 suicides for the whole period of 1887–'99, 263 were among farmers, herdsmen and shepherds, 64 among merchants and tradesmen, 53 of clerks, 53 of soldiers, 28 of metal workers, 28 of shoemakers, and 24 of carpenters.

S. W. A.